National Aeronautics and Space Administration

FY24 Strategic University Research Partnership (SURP)

Quantifying functional stability of California ecosystems using imaging spectroscopy after a decade of drought and fire

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Background: This project is quantifying ecosystem responses to disturbance across California. Results from this project will inform the sensitivity, stability of terrestrial ecosystems' carbon storage, biodiversity to climate change.

Objectives:

1. Characterize fire and drought disturbance histories, phenological shifts across an environmental and ecological gradient in southern California,
2. Estimate plant traits using imaging spectroscopy, and test the transferability of trait mapping models across study sites and years,
3. Analyze plant trait variability in space and time in relation to disturbance regimes and vegetation types.

Approach and Results (Year 2):

During the 2023-24 field seasons, we collected over 500 samples across three NEON sites (*Figure 1*).

We sampled vegetation index time series, vegetation type, climate history, fire history, and topography for pixels across the study region. These data were used to train a random forest regressor model to predict fire resistance (*Figures 2, 3).*

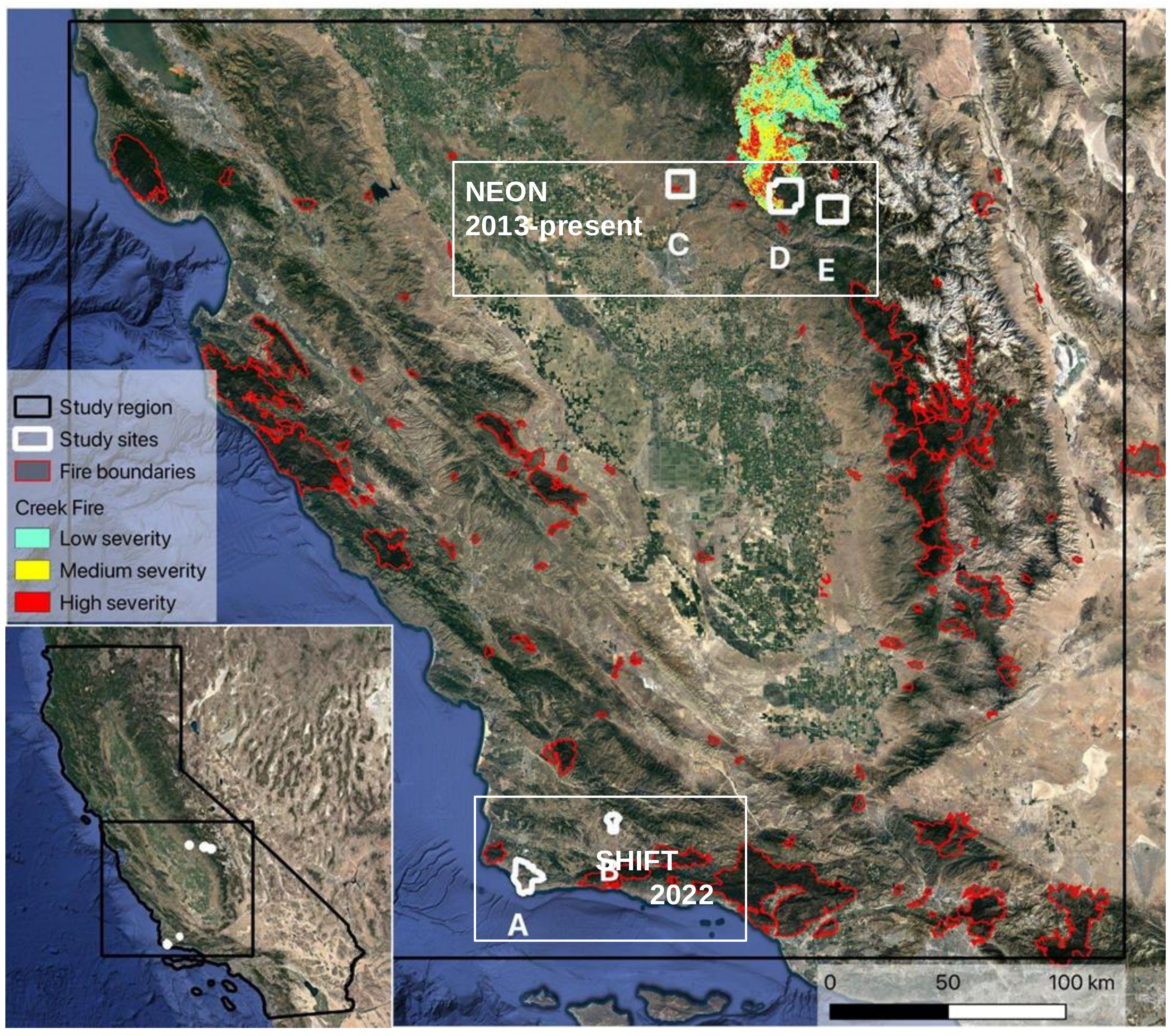

Figure 1. Study region with five study sites (A: Dangermond Preserve, B: Sedgwick Reserve, C: San Joaquin Experimental Range, D: Soaproot Saddle, E: Lower Teakettle). The extent of fire events from 2012-2022 are outlined in red. The 2020 Creek Fire is highlighted as as an example of the fire severity raster data. Fire data are from the Monitoring Trends in Burn Severity dataset.

Takeaways for Objective 1:

- Fire severity, precipitation in the 5 years prior to fire are informative for predicting fire resistance
- Performance was poor for estimating time to recovery, possibly due to choice of recovery baseline

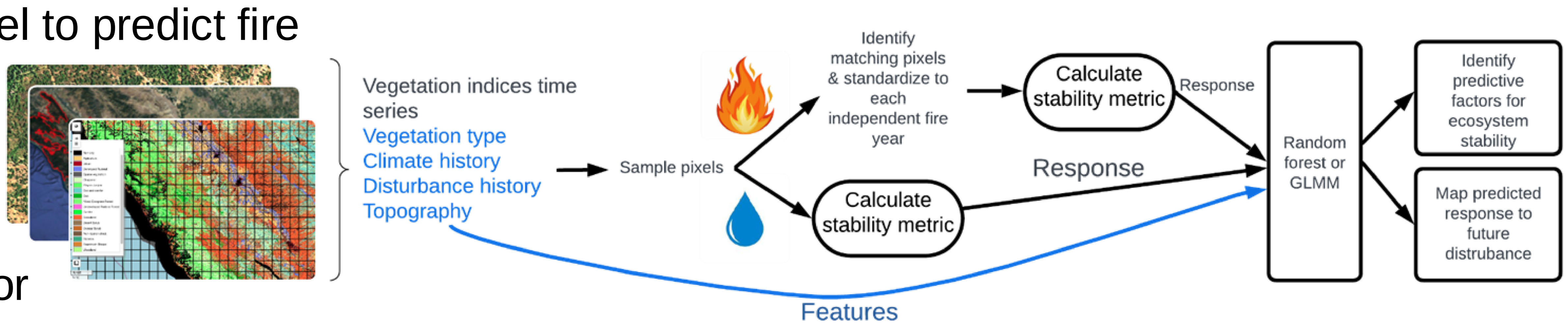

Figure 2. Proposed workflow for Objective 1. We begin by extracting annual peak-greenness Landsat 4-9 NDVI values from 1984-2023, vegetation type, annual precipitation and temperature, fire history from 1984-2023, aspect, and slope for sampled pixels over our study region. We then calculate drought and fire stability metrics. Finally, we train a separate random forest regressor to predict each stability metric.

Objective 1 next steps:

- Implement pixel matching for fire metrics
- Increase number of sampled pixels
- Add drought sensitivity metrics

Objective 2 next steps:

- Finalize trait processing for '24 field season
- Apply ISOFIT 3 atmospheric correction to NEON radiance data
- Develop trait maps over three NEON sites for comparison with SHIFT trait maps

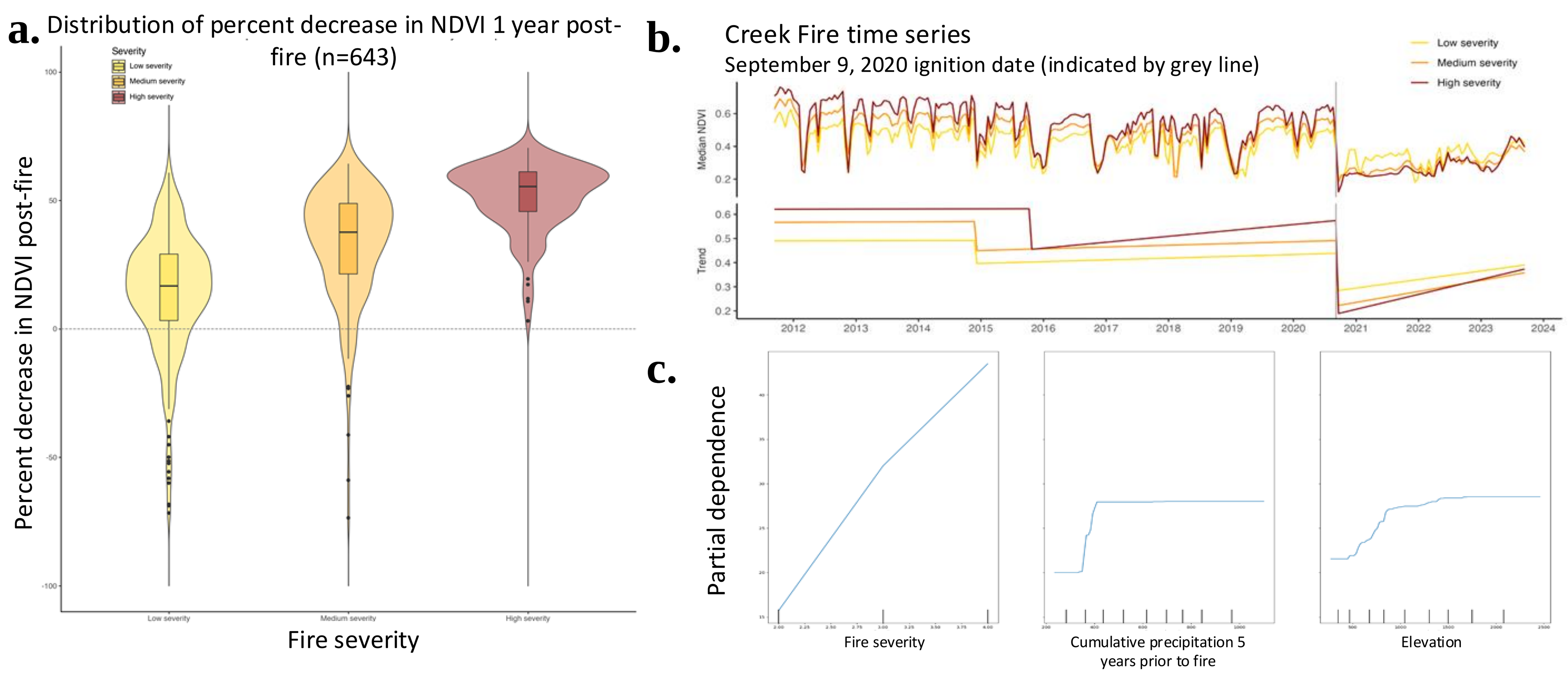

Figure 3. Preliminary results of random forest regressor trained to predict fire resistance (measured as percent decrease in NDVI 1 year post-fire) over 643 pixels sampled between 1984-2024. (a) Distribution of response variable (b) Example time series from 2020 Creek Fire illustrating decrease in NDVI in the 1-year post-fire by fire severity (c) Partial dependence plots for 3 features with the highest feature importance.

Significance/Benefits to JPL and NASA:

- Provide early use cases for data and workflows as they will become available from JPL-led EMIT and SBG missions.
- Utilize the SHIFT and NEON data to study the relationships between biodiversity and ecosystem stability following fire and drought in California ecosystems.

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